

More than 100 different compounds are called cannabinoids, including delta-9-tetrahydrocannabinol (THC) and cannabidiol (CBD). Overall, THC is accepted as responsible for the intoxicating effects of cannabis, while there is little or no evidence that CBD impairs driving (Arkell et al., 2021; Arkell et al., 2020).

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## Prevalence of Driving Under the Influence of Cannabis (DUI-C)

According to the AAA Foundation for Traffic Safety (AAAFTS), between 2013 and 2015, about 5% of drivers self-reported driving within an hour of using marijuana (Arnold & Tefft, 2016). In 2021, about 6% of drivers reported this behavior (AAAFTS, 2023). Analyses of the National Survey on Drug Use and Health (NSDUH) database indicated that between 2016 and 2020 the self-reported prevalence of DUI-C was between 4.2% and 4.9% (Salas-Wright et al., 2021; Myers et al., 2023). Further analyses of the NSDUH data suggest there may be sex differences associated with DUI-C among users of medical and recreational cannabis, with male users of both medical and recreational cannabis more likely to report driving under the influence of cannabis than females (Lloyd et al., 2020).

## Suggested Citation

Romano, E., Romosz, A., Taylor, E., Murphy, J., Thomas, S., Moore, C., & McKnight, S. (2024). *Cannabis Use, Public Health, and Traffic Safety: Outcomes from the Scientific Literature and Expert Opinion on the Potential Impacts of Rescheduling* (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.

## Risk Perceptions

Risk perceptions contribute to shaping risk-related behaviors, which therefore influence crash risk (Benzaman et al., 2022). For example, individuals who consider driving after using cannabis to be a relatively low-risk behavior are more likely to engage in that behavior (Huỳnh et al., 2024).

Ample and consistent evidence shows that individuals who drive after using cannabis are less likely to perceive that behavior to be as dangerous as drinking and driving (AAAFTS, 2022; AAAFTS, 2023; Wickens et al., 2023; Arnold & Tefft, 2016; Boicu et al., 2024).

## Risk Perceptions

Cannabis use is still a concern regarding its possible impact on motor vehicle crashes. To address this concern, research has attempted to measure and examine the contribution of cannabis to crash risk. Broadly speaking, two types of studies were conducted to examine the impact of cannabis use on traffic-related outcomes: (1) laboratory and simulator studies and (2) epidemiological studies.

## **Laboratory and Simulator Studies**

Laboratory and simulator studies have consistently found that the psychomotor skills necessary for safe driving become increasingly impaired at higher doses of cannabis (Sewell et al., 2009). Driving failures such as lane departures tend to occur after acute cannabis use, particularly among occasional cannabis users, in part because daily users can develop tolerance and/or learn how to compensate for drug effects (e.g., by reducing speed) (Miller et al., 2022). Research also found that when cannabis and alcohol are used together, they yield worse driving performances than when cannabis is used alone (Ortiz-Peregrina et al., 2022).

## **Epidemiological Studies**

Although laboratory experiments warn about the impact of cannabis on psychomotor performance, they do not necessarily reflect the complex nature of driving ability in actual scenarios. Epidemiological studies have been designed and conducted to close the gap between laboratory and real-world outcomes. Such studies, however, have shown mixed results (Hall & Lynskey, 2016; Blandino et al., 2022; Berning et al., 2015; Compton & Berning, 2009; Lacey et al., 2009; Rogeberg & Elvik, 2016; Brubacher et al., 2022; Sewell et al., 2009; Asbridge et al., 2014).

On one hand, epidemiological studies have clearly shown a sustained increase in the prevalence of THC use among U.S. drivers, as revealed by the 2007 and 2013–2014 National Roadside Surveys (Berning et al., 2015), as well as by data on visits to the Emergency Department (ED)/trauma centers (Roehler et al., 2022; Crocker et al., 2023; Rudisill et al., 2023; Thomas et al., 2022). However, it is unclear whether the increase in prevalence also reflects an increase in cannabis impairment while driving (Myran et al., 2023). Some of the reasons that blur this relationship are as follows:

- Cannabis users tend to have characteristics that are similar to those shown by drivers with other high crash-risk factors, including polysubstance use (alcohol in particular), and being young and male. All these factors could confound cannabis-related crash risk study results if they are not properly controlled for.
- Determination of cannabis impairment at the roadside is difficult to assess (Ramaekers et al., 2023). The dosage and route of administration impact both the time course and intensity of impairment (Preuss et al., 2021). Data on these factors is usually missing in epidemiological studies (Brands et al., 2021).
- Drugged driving data available in the NHTSA Fatality Analysis Reporting System (FARS) is unreliable because it is incomplete (Berning & Smither, 2014). As such, epidemiological studies based on crash data from FARS also yield unreliable results.
- Despite these difficulties, researchers have attempted a variety of analytical strategies to assess the contribution of cannabis to crash risk.

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## Literature Reviews and Meta Analyses

A variety of reviews as well as meta-analyses based on previous research were conducted to assess the contribution of cannabis to crash risk. In 2017, the NASEM review concluded there was “substantial evidence of a statistical association between cannabis use and increased risk of motor vehicle crashes” (NASEM, 2017, p. 230). The 2017 NASEM report relied somewhat heavily on Rogeberg and Elvik’s (2016) meta-analysis, which concluded that the presence of a THC metabolite in blood, saliva, or urine, was associated with 20 to 30 percent increase in the risk of crash.

On the other hand, a literature review conducted by White and Burns (2023) and a meta-analysis conducted by the same authors (White and Burns, 2021) concluded that the risks from driving after using cannabis are lower than from driving under the influence of alcohol, speeding, or using a mobile phone while driving.

The inconsistent results coming from reviews and meta-analyses are largely due to methodological differences between the studies, including differences in the inclusion and exclusion criteria used to select subjects for these studies (Preuss et al., 2021; Asbridge et al., 2012; White & Burns, 2022; Gjerde & Mørland, 2016).

## Case-Control Studies

In part to overcome the limitations of crash data, governmental agencies have sponsored direct case-control studies aimed at assessing drug and alcohol crash risk.

The European Integrated Project DRUID (Driving Under the Influence of Drugs, Alcohol and Medicines) built a crash-control study across nine European countries by conducting roadside data collection to determine the prevalence of psychoactive substances among drivers, and then merging the prevalence findings with hospital data. The study concluded that drivers faced a “slightly increased risk” when both alcohol was present in the BAC range of 0.01 g/dL to < 0.05 g/dL and drivers were positive for THC (Hels et al., 2011).

In the United States, NHTSA sponsored the Drug Crash Risk study, a direct case-control study examining drug and alcohol crash risk in Virginia Beach, Virginia (Compton & Berning, 2015; Lacey et al., 2016). In this study, control drivers were recruited one week after crashes occurred at the same time, day of week, location, and direction of travel as the crash-involved drivers. The study reported an unadjusted odds ratio of 1.25 associated with the presence of THC. However, after adjusting for gender, age, race/ethnicity, and alcohol, the authors found no indication that any drug significantly contributed to crash risk. The study also reported that when combined with alcohol, cannabis use increases crash risk. However, the joint contribution of cannabis and alcohol to crash risk was not significantly larger than that caused by alcohol alone, a finding coincidental with the finding reported by the European DRUID study (Hels et al., 2011). Secondary analysis of

this data found that cannabis may increase crash risk, but only for drivers ages 64 years old and over (Johnson et al., 2021).

Although the DRUID and NHTSA's Drug Crash Risk studies both suggest a relatively minor contribution of cannabis to crash risk that elevates significantly when cannabis is consumed simultaneously with alcohol, the findings from these studies do not rule out the possibility that cannabis could generate crash risk, because both studies faced limitations:

- The DRUID study was forced to merge data from jurisdictions with varying rules and enforcement procedures with aggregated hospital information.
- The NHTSA study, although homogeneous and rigorous in design and application, was restricted to only one jurisdiction, with the range of THC values obtained from participant drivers not ample enough to allow for an estimation of crash risk under different THC concentrations (only presence vs. absence of the drug was analyzed).

More recently, NHTSA sponsored a study based on the examination of data on seriously injured roadway users from seven trauma centers at selected sites. The study found that active THC was the most prevalent drug (25.1%), followed by alcohol (23.1%), stimulants (10.8%), and opioids (9.3%). Overall, 19.9% of the roadway users were positive for two or more categories of drugs (Berning, 2022; Thomas et al., 2022). However, as the authors observed, although these findings show prevalence and raise concern for potential crash risk, they do not demonstrate driving impairment.

Using data from injury crash cases and non-injury control cases among drivers who were involved in motor vehicle crashes and who went to an ED in Denver, CO; Portland, OR; and Sacramento, CA, for medical care, a recent study found that although the use of cannabis alone does not tend to increase the odds of motor vehicle crashes, that may not be the case after an acute (heavy) use of cannabis, in particular when used with alcohol (Choo et al., 2024).

## Summary

- Laboratory-based research shows that the use of cannabis affects key driving skills.
- Epidemiological studies yield mixed results, largely due to methodological challenges.
- There is evidence that cannabis potency, its route of administration, dosage, frequency of use (tolerance), and polydrug use can impact cannabis impairment and challenge research outcomes when these factors are not properly accounted for.
- There appears to be consensus among researchers that the contribution of cannabis to crash risk increases when the drug is used together with alcohol.

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